PEAK OF FLIGHT NEWSLETTER

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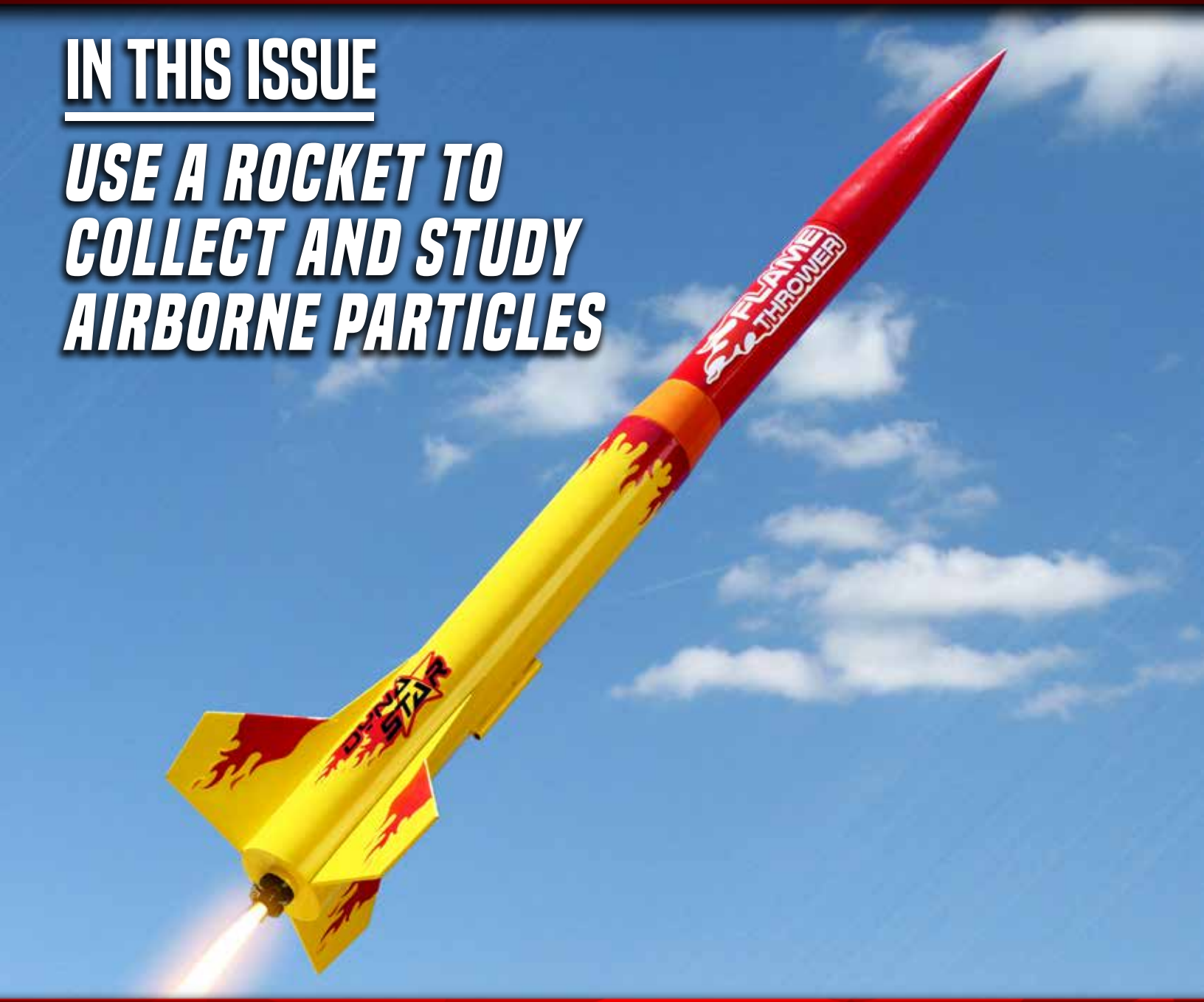

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PEAK OF FLIGHT

Use a Rocket to Collect and Study Airborne Particles

By Bobby Potter

The Launchable Automatic Device for Collecting Airborne Particles (LADCAP) is a small device that can be launched aboard a rocket, weather balloon or high altitude drone in an effort to collect solid particles in our atmosphere. This caught my attention as it would appear to be an interesting way to use rockets for some real world experimentation, and may hold some value at the collegiate level or for a killer science fair experiment.

What is the LADCAP?

The LADCAP device can be mounted inside of a rocket, launched to altitude, and then used to collect solid particles from the atmosphere. It consists of a simple air pump, a 9V battery, and a standard 25mm air filter with a holder. Pretty simple and straightforward, but what you find in samples like these might surprise you.

Extremophiles are microorganisms that can survive in conditions that are otherwise incapable of nurturing life, and they are also the life's work of Dr. Dave Thomas. Dr. Thomas is currently a professor of biology and the chairman of the science division at Lyon College in Arkansas. Over his life, he has studied extremophiles in a variety of environments, most recently in deep caverns.

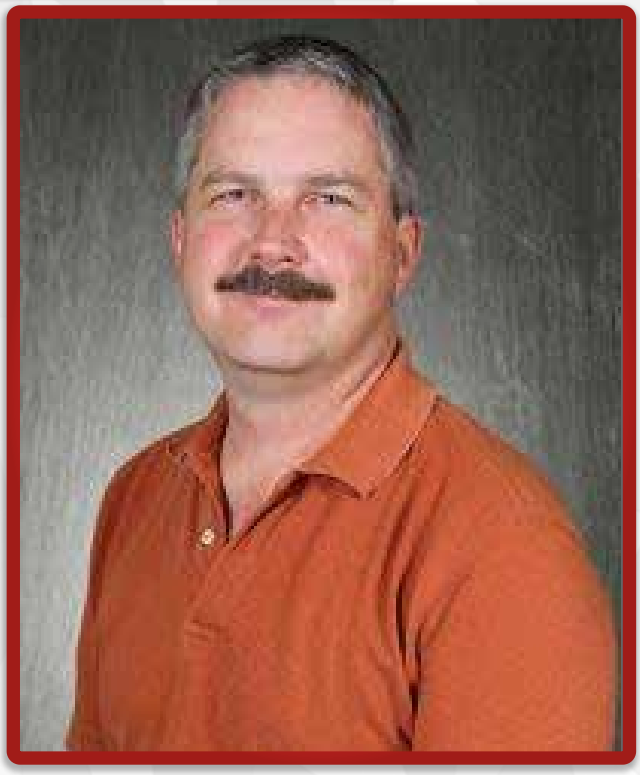

FIGURE 1: DR. DAVID THOMAS

As a rocketry hobbyist, and recently given a lot of free time due to the coronavirus, he decided to develop the LADCAP device to study extremophiles in our atmosphere. He intends to launch this device at increasingly higher altitudes and then compare the samples. There's a lot of value there, but it's hardly the limit of the LADCAP device.

Microorganisms and particles from the Earth's surface are all over our skies, with diverse ecosystems often carried hundreds of miles through jet streams in our atmosphere. The study of these organisms is called aeromicrobiology.

If a volcano erupts on one side of the world you might find particles kicked up from that eruption in samples from the other side of the planet. Dust, mites, microbes, bacteria, spores, and pollen can all travel incredible distances once they are lifted to higher altitudes. They are carried by the winds that are present in our atmosphere, and can be kept aloft indefinitely.

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About this Newsletter

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FIGURE 2: DUST FROM A VOLCANIC ERUPTION BEING CARRIED ACROSS THE PACIFIC.

How do I make one?

The LADCAP device is fairly simple from a construction point of view. It consists of an air pump, a standard 25mm membrane filter, a lithium ion battery and an exhaust tube.

FIGURE 3: THE LADCAP. THIS ENTIRE DEVICE SHOULD BE ABLE TO FIT INSIDE A 29MM ROCKET AIRFRAME WITH ANY MODERATELY SIZED PAYLOAD BAY. DR THOMAS BUILT THIS DEVICE FOR

All of these components are quite easy to source, and all pretty simple. It consists of a membrane filter holder, an air pump, and a lithium 9V battery. There are a few items not in the picture, that Dr. Thomas intends to include in the next design. He wants an altimeter to turn the device on and off, so that he can control when the device is taking samples. This also requires a couple plastic tubes to run from the front of the membrane holder through the airframe tube, and a second line for the exhaust to exit the rocket.

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The pump here is just a simple air pump like this one (https://www.sciplus.com/12vdc-mini-diaphragm-air-pump-49508-p). You can easily acquire one for $10 or less. This device pumps the air through the membrane filter and then out the exhaust channel on the pump. The 25mm membrane filter itself would capture any of the solid particles as the air passed through it. This can then be easily evaluated under a microscope or passed to a growth media and cultured.

The membrane filter holder mounted to the intake of the air pump is a pretty standard component. You can find those filter holders at most scientific surplus stores, or pick some up in bulk here (https://www.coleparmer.com/i/cole-parmer-polypropylene-filter-holder-for-25-mm-membranes-10-pk/0662362)

The lithium 9V battery was chosen because it has less mass than the alkaline alternatives. You can find these pretty much anywhere, and a couple minutes on Amazon should find you what you need.

How can I use this for experiments?

The membrane filter from the LADCAP device can be inspected under a microscope or transferred to a growth media and cultured. If you are trying to study pollutants, dust, or mites, under a microscope is fine. Bacteria and other microbes are much easier to study through cultures.

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FIGURE 4: A PETRI DISH CULTURE.

For the 2020 Arkansas Space Grant Symposium, Dr. Thomas prepared a video to discuss the LADCAP device, its uses and applications in scientific research. You can find that video here (https://www.youtube.com/watch?v=S-CaQ1ID9dQ). The current iteration, the one pictured, was designed to fly on mid-power rocket motors as Dr. Thomas has not yet completed his high-power certifications. In future iterations, he intends to fly this on high-power rockets with the goal of collecting particles from even higher altitudes.

In either case, you can learn a lot from the particulates in our atmosphere. In his presentation he discussed how particles and dust from a volcano can be carried across the pacific. This device would be able to collect those particles for further inspection.

Pollutants also seem like a great area for research using this device. How does the air above Los Angeles, Cal-

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ifornia compare to the air above, say, Casper, Wyoming? I imagine there is quite a difference, and it would be quite interesting to look at those samples under a microscope.

It seems like the end goal here is to launch these devices to incredibly high altitudes, likely outside the range of model rockets. One area ripe for research is the microbes and other forms of basic life that are kept aloft and can be found in our stratosphere. This is quite likely the outer limit of life on our planet, and that life is subjected to incredibly harsh conditions. The stratosphere is quite cold, but it also has very little protection from ultraviolet light. Devices like the LADCAP could make research on these extremophiles much more cost effective.

Other Uses of the LADCAP

Currently the LADCAP is being installed in the LOC Hi-Tech (https://www.apogeerockets.com/Rocket_Kits/Skill_Level_3_Kits/Hi-Tech). This kit has ample room for the LADCAP device and will allow Dr. Thomas to move up into higher power motors as he completes his certifications. It is also a 38mm motor mount with just a 2.6" airframe, making it a good choice to go for maximum altitude.

FIGURE 5: THE LOC HI-TECH

In the video, he also mentions alternative devices for the LADCAP to be flown on. He mentions both weather balloons and drones as viable options, but each of these have some drawbacks. For one, the entry cost of balloons and drones are way higher. For a rocket capable of launching the LADCAP, you might spend $100 including the motor. For a drone capable of a similar altitude, it could be over $1,000. Balloons have similar cost barriers, but in helium. Helium has been rising in price, and enough for a weather balloon would run you around $500 per flight.

There are some benefits to these options though. Drones have a nearly $0 cost per flight, as they just use

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rechargeable lithium ion batteries. Weather balloons give you a much greater sampling time than rockets or a drone would, having flights that last multiple hours.

	BalloonSat	Rocket	Drone
Maximum altitude	20-30+ km	1-100 km	6 km
Horizontal range	30+ km uncontrolled	1+ km uncontrolled	5 km LOS controlled
Flight/sampling time	Many hours	<15 minutes	20-30 minutes
Vehicle cost	$500+	$100+	$1600+
Launch cost	$500	$30+ (depending on altitude)	Essentially free (cost of battery recharge)
Example	ASU BalloonSat	LOC Precision Hi-Tech	DJI Phantom Pro

FIGURE 6: COMPARISON CHART BY DR. DAVE THOMAS REGARDING THE DIFFERENT DEPLOYMENT METHODS.

In the end, rockets seem like a happy medium. Low vehicle cost, low cost of launch, and capable of much higher altitudes than a drone would be. At the collegiate level, rocketeers are already making rockets capable of immense altitudes. MIT came by Apogee Components earlier in the year and showed us their single-stage rocket (The Hermes III) which flew just a few days later to 80k feet-plenty of altitude for some real atmospheric sampling.

While that is not quite to the stratosphere, even that goal may not need orbital class rockets. The Fathom II, the current record holder for highest collegiate rocket launch, launched to 27 miles high - just 4 miles short of the stratosphere.

That being said, these extreme rockets are not on the hobbyist budget and do require much more powerful motors than the ones that are easily available.

The Troposphere is where most model rockets are launched to, and fortunately for us it is ripe with life. There is far less biological life in the air as there is in the soil or the water of the oceans, but some of the life you will find in the troposphere may have traveled an extremely long way.

The Optimal Collection Phase

For his presentation, he defined the sampling time as <15 minutes. He came to this conclusion by assuming all time from apogee to touchdown was a good time for collecting. For a more perfect representation of the particles you would find at altitude, you could refine the sampling time to start and end in between apogee and a certain low-limit altitude (like you would do for a main chute on a dual-deployment system).

Which brings me to dual deployment systems. Typically when using dual deployment, you are trying to reduce the rocket drift by deploying a small chute (called a drogue) to allow the rocket to fall quickly with minimal drift before deploying the main chute to actually slow the fall enough to prevent damage on impact. This may not be the best case here.

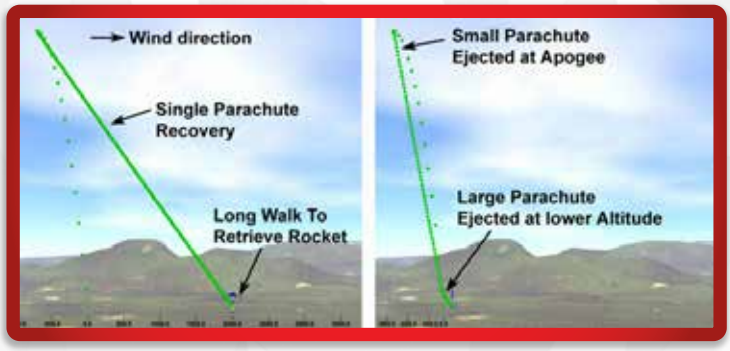

FIGURE 7: COMPARISON OF ROCKSIM SIMULATIONS, ONE WITH A SINGLE LARGE CHUTE (LEFT), ONE WITH A DUAL-DEPLOYMENT SYSTEM (RIGHT).

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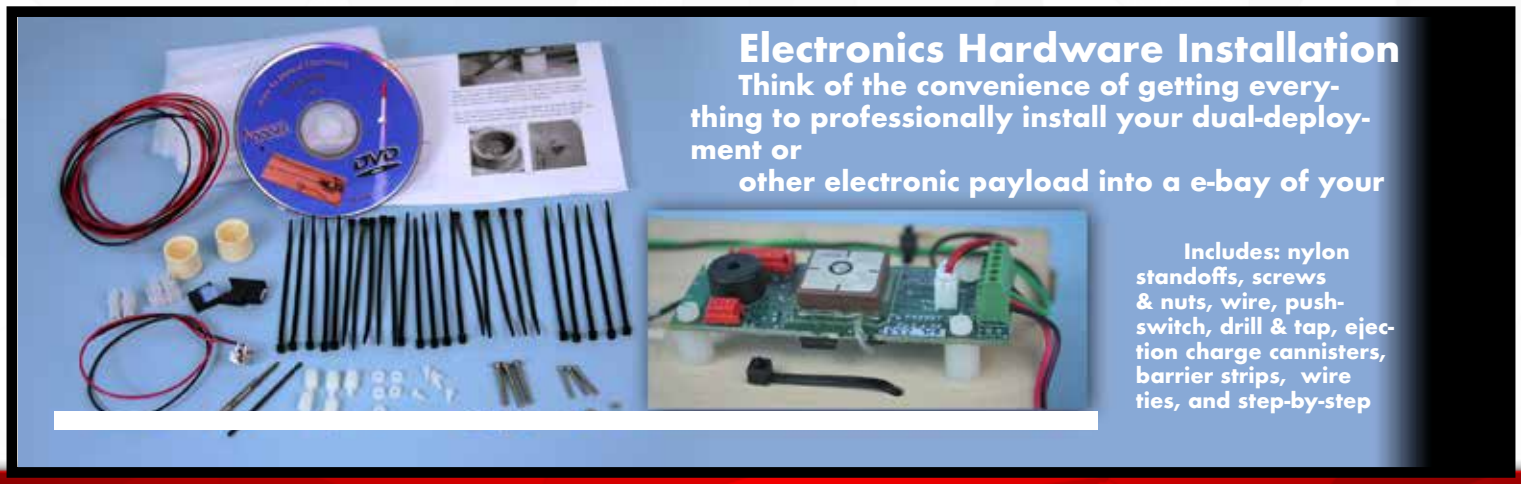
To improve sampling times, a large parachute might be a good choice. This will keep it at an acceptable altitude for sampling for a longer duration, but you will pay for it with rocket drift. If you deployed a large parachute at 3,000ft, you could expect to walk miles to find the rocket again. However if you want that additional sample time, I don't see another alternative. Your best bet would be to put a GPS tracker in that thing and get to walking.

Conclusion

Overall, this is an interesting development for rocketry as it applies to education. Taking atmospheric samples could be an interesting way to incorporate rocketry into biology or other research and experiments. It provides a great way to take samples directly from the atmosphere, and at a price point accessible to anyone.

Our atmosphere, specifically as far as biology is concerned, is relatively unstudied. The first sample taken from our stratosphere found to have biological life occurred in just 2001. Even still, this life is pretty secluded and we have not done much research into what all can be found there. The reason why is simple: It's challenging and expensive to conduct this type of research, but perhaps the LADCAP will have an impact there.

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